# 4. FORECASTS OF POPULATION AND MUNICIPAL WATER USE

## 4.1 General

The forecast of future water demands on the transmission system for this feasibility study is based on the projected growth in population, and selected allowances in per capita consumption that reflect the limited water resources available in Jordan. These are based on a review of previous studies, discussions with the Department of Statistics on population growth, and development of a forecast that is subject to review and agreement among the concerned agencies (primarily WAJ and MWI), and on-going programs and studies (primarily the WLRP). Development of the forecasts is described in this section, including both municipal water supply (domestic, commercial, institutional and industrial water use) and municipal wastewater (generation, collection and treatment, and wastewater reuse).

## 4.2 Population Forecast

The population within Jordan has grown rapidly over the last fifty years, but at declining annual growth rates as a result of social and economic changes. Jordan has received a large influx of refugees, primarily after the 1967 Israeli war, and during 1990-1991 as a result of the first Gulf War. The most accurate data are available from national censuses, which enumerated the national population with the following results: 901,000 in 1961; 2,133,000 in 1979; and 4,139,000 in 1994. The Department of Statistics has provided estimates of the population in the years following the 1994 census, which indicate a national population of 5,480,000 in 2003. A 2004 national housing census began in July 2004, followed by a population census in October 2004; the final results of the census will not be published until late in 2005.

The Department of Statistics in early 2004 prepared a population forecast to year 2030, using a methodology incorporated into a UNDP-sponsored software package called DemProj, which uses the age-sex population distribution and age-specific fertility and mortality rates to make the forecast. This methodology is considered by the Department of Statistics to be more refined and accurate than previous forecasts, which relied upon extrapolations of a single factor, namely, the annual growth rate. **Table 4-1** shows the demographic statistics from the forecast of national population to year 2030, when Jordan's population is expected to be about 8.4 million. By 2030 the annual growth rate is expected to decline to less than 1%, from about 3% currently. This decline in growth rate is similar to that seen previously in the 1960s in Western Europe, when the fertility rate (children per woman) declined rapidly from 2.5 children to 1.5 children in a brief period of 7 years after the use of birth-control pills became common.

Based on discussions with the Department of Statistics, it is expected that growth will be fairly uniform across Jordan; it has been observed that the rural-to-city migration is nearing its end, or has reversed. This is attributed to improvements in the road network, so that more people are staying in small towns and commuting to work in the urban centers. Only the Aqaba region of Jordan is growing faster than the national rate.

On this basis, a preferred forecast of population for the northern governorates has been prepared, which is shown in **Table 4-2** and **Figure 4-1** in comparison with three previous studies. The population growth rate in Jordan has been declining over the years, and thus each successive study has adopted a lower set of growth rates. The 1997 Sogreah study

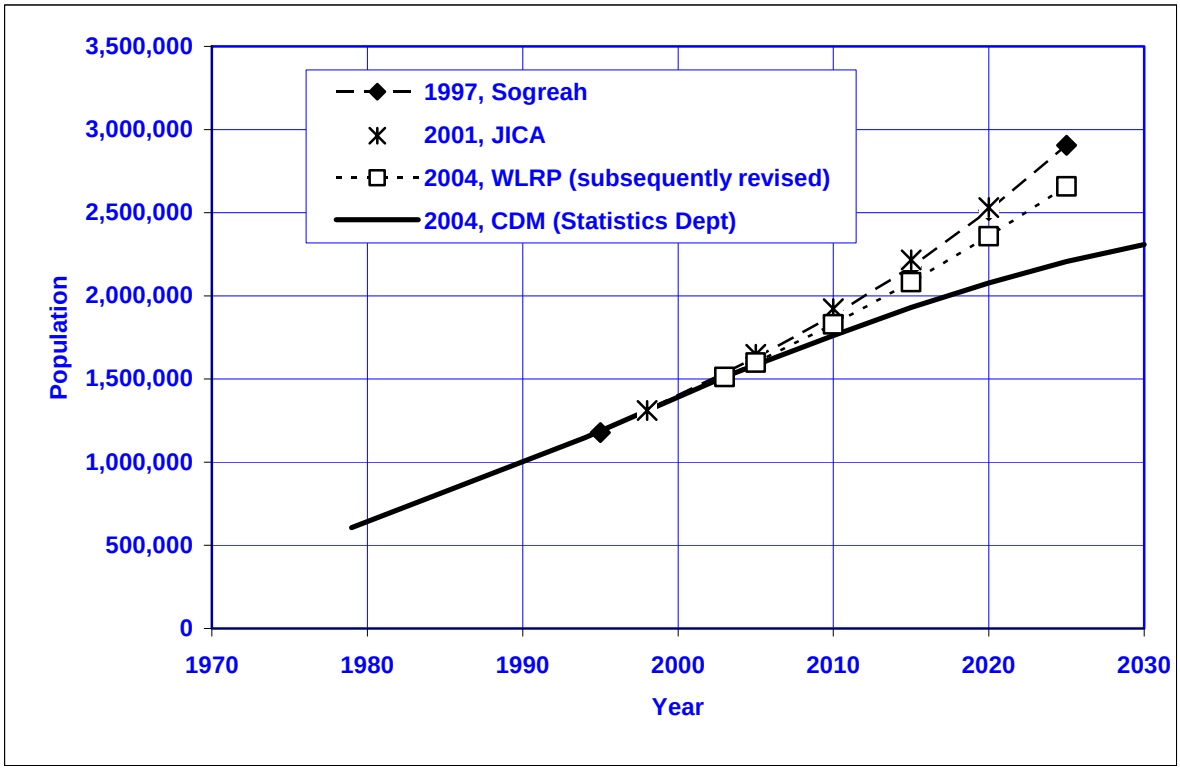
assumed a growth rate of about 3% through 2025; the 2001 JICA study assumed a decline in growth rate from 3.3% to 2.7% through the year 2020; and a preliminary 2004 WLRP estimate (subsequently revised) assumed a decline from 2.8% to 2.4% through 2025. The results in **Table 4-2** indicate a population of about 2.3 million for the NGWA service area in 2030, which is less than the design populations predicted in the previous studies. The WLRP, NWMP and this study are now using the same population forecasts, based on the most recent methodology of the Department of Statistics.

**Table 4-1 Forecast of Demographic Indicators for Jordan, 2005-2030**

| Item | 2003 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| **Fertility** | | | | | | | |
| Total Fertility Rate, Children/Woman | 3.7 | 3.2 | 2.8 | 2.4 | 2.1 | 1.8 | 1.5 |
| Mean Age of Childbearing, years | 28.8 | 28.2 | 27.8 | 27.5 | 27.3 | 27.2 | 27.2 |
| **Mortality** | | | | | | | |
| Male Life Expectancy, years | 70.6 | 71.1 | 72.3 | 73.4 | 74.6 | 75.8 | 76.9 |
| Female Life Expectancy, years | 72.4 | 73.3 | 74.7 | 76.1 | 77.6 | 79.0 | 80.5 |
| Child (<5years) Mortality Rate/1000 | 28.3 | 25.3 | 20.4 | 16.4 | 12.7 | 8.9 | 6.2 |
| **Vital Rates** | | | | | | | |
| Crude Birth Rate/1000 | 28.9 | 26.0 | 24.0 | 21.0 | 18.1 | 15.0 | 12.3 |
| Crude Death Rate/1000 | 4.0 | 3.8 | 4.1 | 4.3 | 4.5 | 4.3 | 4.4 |
| Rate of Natural Increase,% | 2.49% | 2.22% | 2.00% | 1.67% | 1.36% | 1.06% | 0.79% |
| Doubling Time, years | 28.2 | 31.5 | 35.1 | 41.9 | 51.2 | 65.6 | 88.5 |
| **Annual Births, 1000s** | 158.43 | 149.27 | 153.22 | 146.98 | 136.69 | 119.57 | 102.79 |
| **Annual Deaths, 1000s** | 22.03 | 21.61 | 25.91 | 30.33 | 33.97 | 34.68 | 37.02 |
| **Population, millions** | | | | | | | |
| Total Population | 5.48 | 5.74 | 6.38 | 6.99 | 7.53 | 7.99 | 8.36 |
| Male Population | 2.87 | 3.00 | 3.32 | 3.62 | 3.89 | 4.12 | 4.30 |
| Female Population | 2.61 | 2.74 | 3.06 | 3.37 | 3.64 | 3.87 | 4.06 |
| **Population by Age Group, %** | | | | | | | |
| Percent, 0-4 years | 12.10% | 11.86% | 11.70% | 10.56% | 9.27% | 7.82% | 6.51% |
| Percent, 5-14 years | 25.70% | 24.67% | 21.84% | 20.35% | 19.67% | 17.94% | 15.81% |
| Percent, 15-49 years | 51.00% | 52.04% | 54.50% | 56.21% | 56.57% | 57.50% | 57.80% |
| Percent, 50-64 years | 7.70% | 7.40% | 7.44% | 7.97% | 9.48% | 11.42% | 13.75% |
| Percent, 65 and over | 3.50% | 4.04% | 4.52% | 4.90% | 5.01% | 5.32% | 6.14% |
| **Median Age, years** | 20 | 21 | 23 | 24 | 26 | 29 | 31 |

Source: Department of Statistics data on population forecasts using UNDP DemProj

**Figure 4-1 Comparison of Population Forecasts, NGWA Service Area**



# TABLE 4-2 Comparison of Population Forecasts for the NGWA Service Area

**(A) 1997 Sogreah Hydraulic Analysis Study, "Medium Hypothesis"**

| Governorate | 1979 | 1994 | 1995 | 2005 | 2010 | 2015 | 2020 | 2025 | 1979-95 | 2005 | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Population | | | | | | | | Growth Rate to Given Year | | | | | |
| Irbid | 412,462 | 751,634 | 778,806 | 1,057,798 | 1,213,499 | 1,392,117 | 1,596,683 | 1,831,000 | 4.05% | 3.11% | 2.78% | 2.78% | 2.78% | 2.78% |
| Jerash | 66,105 | 123,190 | 127,951 | 175,881 | 202,858 | 233,973 | 269,794 | 311,000 | 4.21% | 3.23% | 2.90% | 2.90% | 2.89% | 2.88% |
| Ajloun | 51,187 | 94,548 | 92,103 | 122,218 | 138,748 | 157,515 | 178,823 | 203,000 | 3.74% | 2.87% | 2.57% | 2.57% | 2.57% | 2.57% |
| Mafraq | 77,299 | 178,914 | 178,935 | 271,073 | 325,072 | 389,828 | 467,485 | 560,610 | 5.39% | 4.24% | 3.70% | 3.70% | 3.70% | 3.70% |
| **Total** | 607,053 | 1,148,286 | 1,177,795 | 1,626,970 | 1,880,177 | 2,173,433 | 2,512,785 | 2,905,610 | 4.23% | 3.28% | 2.94% | 2.94% | 2.94% | 2.95% |

**(B) 2001 JICA Water Resources Management Study, "Scenarios 1 & 2"**

| Governorate | 1979 | 1994 | 1998 | 2005 | 2010 | 2015 | 2020 | 2025 | 1979-98 | 2005 | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Population | | | | | | | | Growth Rate to Given Year | | | | | |
| Irbid | 412,462 | 751,634 | 857,936 | 1,078,734 | 1,257,320 | 1,450,338 | 1,655,982 | | 3.93% | 3.33% | 3.11% | 2.90% | 2.69% | |
| Jerash | 66,105 | 123,190 | 141,492 | 177,906 | 207,359 | 239,192 | 273,107 | | 4.09% | 3.33% | 3.11% | 2.90% | 2.69% | |
| Ajloun | 51,187 | 94,548 | 117,276 | 147,458 | 171,870 | 198,255 | 226,365 | | 4.46% | 3.33% | 3.11% | 2.90% | 2.69% | |
| Mafraq | 77,299 | 178,914 | 194,792 | 244,923 | 285,471 | 329,295 | 375,986 | | 4.98% | 3.33% | 3.11% | 2.90% | 2.69% | |
| **Total** | 607,053 | 1,148,286 | 1,311,496 | 1,649,021 | 1,922,020 | 2,217,080 | 2,531,440 | | 4.14% | 3.33% | 3.11% | 2.90% | 2.69% | |

**(C) 2004 MWH Water Loss Reduction Program (subsequently revised)**

| Governorate | 1979 | 1994 | 2003 | 2005 | 2010 | 2015 | 2020 | 2025 | 1979-94 | 1979-03 | 2005 | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Population | | | | | | | | Growth Rate to Given Year | | | | | | |
| Irbid | 412,462 | 751,634 | 977,635 | 1,033,752 | 1,182,777 | 1,346,711 | 1,525,911 | 1,720,541 | 4.08% | 3.66% | 2.83% | 2.73% | 2.63% | 2.53% | 2.43% |
| Jerash | 66,105 | 123,190 | 161,115 | 170,429 | 195,188 | 222,458 | 252,306 | 284,765 | 4.24% | 3.78% | 2.85% | 2.75% | 2.65% | 2.55% | 2.45% |
| Ajloun | 51,187 | 94,548 | 121,660 | 128,643 | 147,189 | 167,589 | 189,889 | 214,110 | 4.18% | 3.67% | 2.83% | 2.73% | 2.63% | 2.53% | 2.43% |
| Mafraq | 77,299 | 178,914 | 252,125 | 266,286 | 303,785 | 344,880 | 389,630 | 438,042 | 5.75% | 5.05% | 2.77% | 2.67% | 2.57% | 2.47% | 2.37% |
| **Total** | 607,053 | 1,148,286 | 1,512,535 | 1,599,110 | 1,828,939 | 2,081,638 | 2,357,736 | 2,657,458 | 4.34% | 3.88% | 2.82% | 2.72% | 2.62% | 2.52% | 2.42% |

**(D) 2004 CDM Forecast to 2030 (Dept of Statistics Methodology)**

| Governorate | 1979 | 1994 | 2003 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Population | | | | | | | | | Growth Rate to Given Year | | | | | |
| Irbid | 412,462 | 751,634 | 977,635 | 1,024,019 | 1,138,195 | 1,247,020 | 1,343,356 | 1,425,420 | 1,491,429 | 2.34% | 2.14% | 1.84% | 1.50% | 1.19% | 0.91% |
| Jerash | 66,105 | 123,190 | 161,115 | 168,759 | 187,575 | 205,510 | 221,386 | 234,910 | 245,789 | 2.34% | 2.14% | 1.84% | 1.50% | 1.19% | 0.91% |
| Ajloun | 51,187 | 94,548 | 121,660 | 127,432 | 141,641 | 155,183 | 167,171 | 177,384 | 185,598 | 2.34% | 2.14% | 1.84% | 1.50% | 1.19% | 0.91% |
| Mafraq | 77,299 | 178,914 | 252,625 | 264,611 | 294,115 | 322,235 | 347,129 | 368,335 | 385,391 | 2.34% | 2.14% | 1.84% | 1.50% | 1.19% | 0.91% |
| **Total** | 607,053 | 1,148,286 | 1,513,035 | 1,584,821 | 1,761,526 | 1,929,948 | 2,079,043 | 2,206,049 | 2,308,207 | 2.34% | 2.14% | 1.84% | 1.50% | 1.19% | 0.91% |
| **Jordan** | 2,133,000 | 4,139,400 | 5,480,000 | 5,740,000 | 6,380,000 | 6,990,000 | 7,530,000 | 7,990,000 | 8,360,000 | 2.34% | 2.14% | 1.84% | 1.50% | 1.19% | 0.91% |

## 4.3 Water Demand Forecast

A forecast of municipal water consumption and water production required through year 2030 has been prepared, based on the allowances for per capita consumption and physical water losses adopted in previous studies, and subsequent discussions with the developers of the recent National Water Master Plan. The build-up of the forecast is shown in **Table 4-3**, and a summary is shown in **Table 4-4**. The unaccounted-for water (UFW) in the early years, 2002-2010, has been assumed as split equally between physical losses (leakage) and administrative losses(meter under-registration, stopped meters, errors of estimated use, un-metered public use, illegal use, billing errors, etc.) Consumption is taken to include both the metered water use and the administrative losses, since the administrative water loss reaches the customers. A more detailed build-up of the water forecasts has been used in the WLRP, taking into account forecasts of per capita flows and water losses by ROU or city, and is not repeated here.

The results indicate a large deficit in production at present, which will continue until such time as the WLRP has been carried out. The per capita use of 78 lpcd in 2002 is very low compared to the target of about 130 lpcd adopted for the years 2020 and thereafter. The year 2015 has been adopted herein as the target date for reducing physical water losses to a range of 10% to 15%, which are the target values of the WLRP. As previously noted, this is a very ambitious target. As also noted, if these targets are not reached when scheduled, the effect will be to move forward the time by which certain levels of production will be required. By the planning horizon of 2030, the required water production is estimated at 125 million cubic meters per year (MCM/year), representing a required increase in production of 69 MCM/year compared to the actual production in 2002.

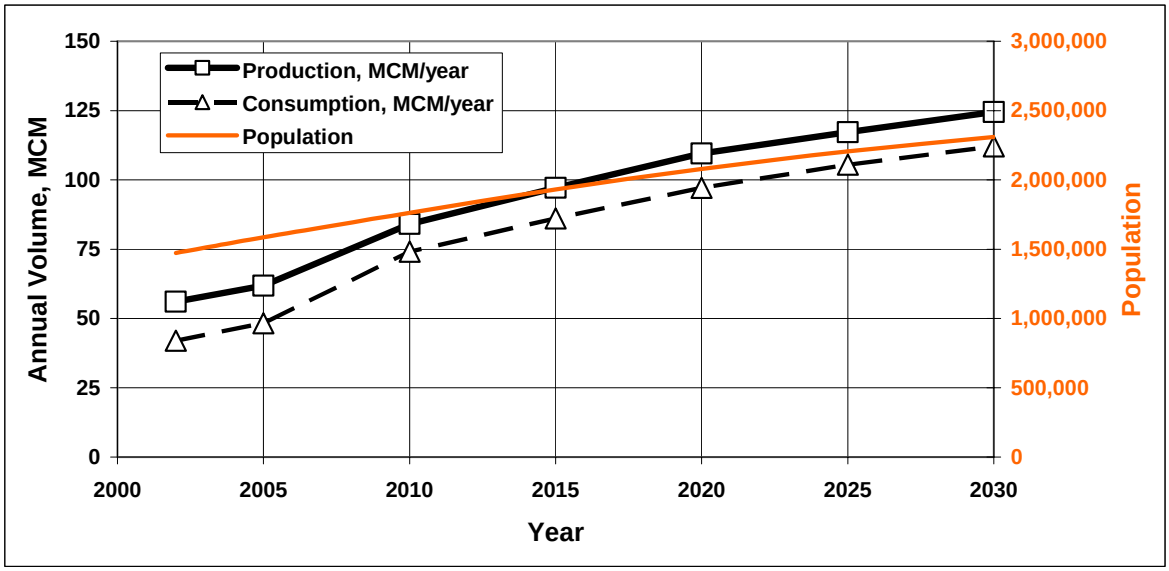
The preliminary results of the GTZ-funded National Water Master Plan (NWMP) were presented at a seminar on July 18-19 2004, and subsequent discussions were held with the developers of the NWMP. The forecast adopted for this study is in agreement with a "modified Scenario 2" forecast prepared by the NWMP team and discussed in meetings on 29 August 2004. The NWMP forecast covers the period 2005-2020, and has been extrapolated to the year 2030 for use in this study. The forecast for year 2030 is essentially the same as that adopted by the WLRP for the year 2025.

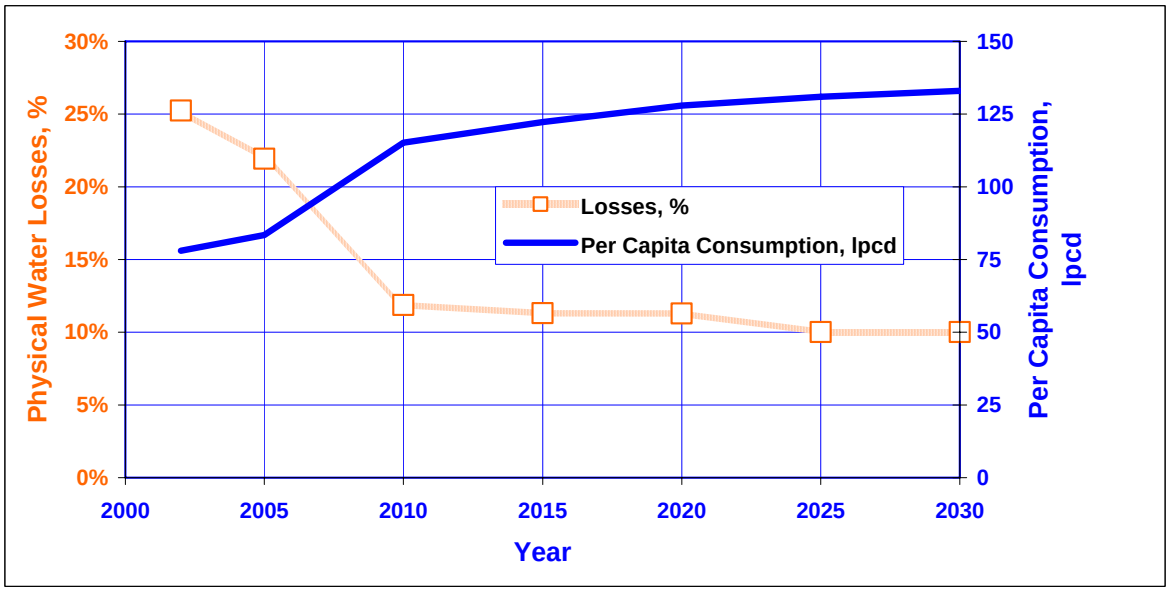
**TABLE 4-3 Components of NGWA Water Demand Forecast, 2005-2030**

| Governorate | 2002 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| | **Population** | | | | | | |
| Irbid | 950,695 | 1,024,019 | 1,138,195 | 1,247,020 | 1,343,356 | 1,425,420 | 1,491,429 |
| Jerash | 156,675 | 168,759 | 187,575 | 205,510 | 221,386 | 234,910 | 245,789 |
| Ajloun | 118,305 | 127,432 | 141,641 | 155,183 | 167,171 | 177,384 | 185,598 |
| Mafraq | 245,665 | 264,611 | 294,115 | 322,235 | 347,129 | 368,335 | 385,391 |
| Total | 1,471,340 | 1,584,821 | 1,761,526 | 1,929,948 | 2,079,043 | 2,206,049 | 2,308,207 |
| **Governorate** | **Potential Per Capita Demand, liters/capita/day (including water losses)** | | | | | | |
| Irbid | 128 | 130 | 134 | 136 | 142 | 146 | 148 |
| Jerash | 98 | 107 | 134 | 136 | 142 | 146 | 148 |
| Ajloun | 98 | 107 | 144 | 147 | 151 | 146 | 148 |
| Mafraq | 190 | 150 | 145 | 144 | 151 | 146 | 148 |
| Total | 133 | 129 | 137 | 138 | 144 | 146 | 148 |
| **Governorate** | **Potential Water Demand, MCM/year** | | | | | | |
| Irbid | 44,416,470 | 48,589,708 | 55,669,142 | 61,699,770 | 69,735,109 | 75,729,417 | 80,446,000 |
| Jerash | 5,604,265 | 6,562,411 | 9,174,317 | 10,168,170 | 11,492,400 | 12,480,266 | 13,257,563 |
| Ajloun | 4,231,770 | 4,955,891 | 7,444,633 | 8,329,681 | 9,188,532 | 9,424,009 | 10,010,955 |
| Mafraq | 17,079,854 | 14,487,444 | 15,524,721 | 16,881,332 | 19,079,837 | 19,568,800 | 20,787,585 |
| Total | 71,332,359 | 74,595,455 | 87,812,813 | 97,078,953 | 109,495,877 | 117,202,492 | 124,502,104 |
| **Governorate** | **Deficit in Supply, MCM/year (Demand not met)** | | | | | | |
| Irbid | 13,063,602 | 11,213,010 | 3,738,972 | 0 | 0 | 0 | 0 |
| Jerash | 1,468,101 | 876,526 | 45,643 | 0 | 0 | 0 | 0 |
| Ajloun | 737,533 | 662,407 | 0 | 0 | 0 | 0 | 0 |
| Mafraq | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 15,269,236 | 12,751,942 | 3,784,616 | 0 | 0 | 0 | 0 |
| **Governorate** | **Target Water Production, MCM/year** | | | | | | |
| Irbid | 31,352,868 | 37,376,699 | 51,930,169 | 61,699,770 | 69,735,109 | 75,729,417 | 80,446,000 |
| Jerash | 4,136,164 | 5,685,885 | 9,128,674 | 10,168,170 | 11,492,400 | 12,480,266 | 13,257,563 |
| Ajloun | 3,494,237 | 4,293,485 | 7,444,633 | 8,329,681 | 9,188,532 | 9,424,009 | 10,010,955 |
| Mafraq | 17,079,854 | 14,487,444 | 15,524,721 | 16,881,332 | 19,079,837 | 19,568,800 | 20,787,585 |
| Total | 56,063,123 | 61,843,513 | 84,028,197 | 97,078,953 | 109,495,877 | 117,202,492 | 124,502,104 |
| **Governorate** | **Water Consumption, MCM/year (including administrative losses)** | | | | | | |
| Irbid | 24,743,704 | 29,901,359 | 46,737,152 | 55,529,793 | 62,761,598 | 68,156,475 | 72,401,400 |
| Jerash | 3,371,229 | 4,690,855 | 7,987,590 | 9,151,353 | 10,343,160 | 11,232,240 | 11,931,806 |
| Ajloun | 2,782,940 | 3,542,125 | 6,514,054 | 7,080,229 | 7,810,252 | 8,481,608 | 9,009,860 |
| Mafraq | 11,016,755 | 10,141,211 | 12,807,895 | 14,349,132 | 16,217,861 | 17,611,920 | 18,708,827 |
| Total | 41,914,627 | 48,275,550 | 74,046,691 | 86,110,507 | 97,132,871 | 105,482,243 | 112,051,893 |
| **Governorate** | **Physical Water Losses, % of Production** | | | | | | |
| Irbid | 21.1% | 20.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% |
| Jerash | 18.5% | 17.5% | 12.5% | 10.0% | 10.0% | 10.0% | 10.0% |
| Ajloun | 20.4% | 17.5% | 12.5% | 15.0% | 15.0% | 10.0% | 10.0% |
| Mafraq | 35.5% | 30.0% | 17.5% | 15.0% | 15.0% | 10.0% | 10.0% |
| Total | 25.2% | 21.9% | 11.9% | 11.3% | 11.3% | 10.0% | 10.0% |
| **Governorate** | **Administrative Water Losses, % of Production** | | | | | | |
| Irbid | 21.1% | 20.0% | 10.0% | 10.0% | 10.0% | 10.0% | 10.0% |
| Jerash | 18.5% | 17.5% | 12.5% | 10.0% | 10.0% | 10.0% | 10.0% |
| Ajloun | 20.4% | 17.5% | 12.5% | 10.0% | 10.0% | 10.0% | 10.0% |
| Mafraq | 35.5% | 30.0% | 17.5% | 10.0% | 10.0% | 10.0% | 10.0% |
| Total | 25.2% | 21.9% | 11.9% | 10.0% | 10.0% | 10.0% | 10.0% |
| **Governorate** | **Unaccounted-For Water (UFW), % of Production** | | | | | | |
| Irbid | 42.2% | 40.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% |
| Jerash | 37.0% | 35.0% | 25.0% | 20.0% | 20.0% | 20.0% | 20.0% |
| Ajloun | 40.7% | 35.0% | 25.0% | 25.0% | 25.0% | 20.0% | 20.0% |
| Mafraq | 71.0% | 60.0% | 35.0% | 25.0% | 25.0% | 20.0% | 20.0% |
| Total | 50.5% | 43.9% | 23.8% | 21.3% | 21.3% | 20.0% | 20.0% |
| **Governorate** | **Per Capita Consumption, l/c/d (including administrative losses)** | | | | | | |
| Irbid | 71 | 80 | 113 | 122 | 128 | 131 | 133 |
| Jerash | 59 | 76 | 117 | 122 | 128 | 131 | 133 |
| Ajloun | 64 | 76 | 126 | 125 | 128 | 131 | 133 |
| Mafraq | 123 | 105 | 119 | 122 | 128 | 131 | 133 |
| Total | 78 | 83 | 115 | 122 | 128 | 131 | 133 |

## Table 4-4 Summary of Water Forecast, NGWA Service Area

| Item | 2002 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| Population | 1,471,340 | 1,584,821 | 1,761,526 | 1,929,948 | 2,079,043 | 2,206,049 | 2,308,207 |
| Potential Per Capita Demand, lpcd | 133 | 129 | 137 | 138 | 144 | 146 | 148 |
| Potential Water Demand, MCM/year | 71.3 | 74.6 | 87.8 | 97.1 | 109.5 | 117.2 | 124.5 |
| Deficit in Supply, MCM/year | 15.3 | 12.8 | 3.8 | 0 | 0 | 0 | 0 |
| Production, MCM/year | 56.06 | 61.84 | 84.03 | 97.08 | 109.50 | 117.20 | 124.50 |
| Consumption, MCM/year | 41.91 | 48.28 | 74.05 | 86.11 | 97.13 | 105.48 | 112.05 |
| Physical Losses, % | 25.2% | 21.9% | 11.9% | 11.3% | 11.3% | 10.0% | 10.0% |
| Per Capita Use, lpcd | 78 | 83 | 115 | 122 | 128 | 131 | 133 |
| Avg. Demand, m3/hour | 6,400 | 7,060 | 9,592 | 11,082 | 12,500 | 13,379 | 14,213 |
| Max. Day Demand, m3/hour | 7,680 | 8,472 | 11,511 | 13,298 | 14,999 | 16,055 | 17,055 |



## 4.4 Municipal Wastewater Forecast

### 4.4.1 General

The focus of the present study is on municipal water supply in the northern governorates, but in order to provide a comprehensive picture on water demands, water resources, and water allocations within the study area, it is desirable to examine briefly the forecast of wastewater quantities and to contrast this with the current and planned development of wastewater facilities for wastewater collection, treatment, disposal and effluent reuse (particularly for agricultural reuse).

### 4.4.2 Wastewater Generation

Once piped water supply into a community is increased, the need for wastewater collection, treatment and disposal will also increase. On-site private septic tanks or cesspits cannot be expected to provide adequate treatment and disposal of wastewater, when much of the population reside in urban areas on small building lots underlain by karst formations. Lack of wastewater infrastructure leads to an unhealthy and deteriorated urban environment. Continued development of municipal wastewater systems will be required to prevent environmental degradation and to promote wastewater reuse for irrigation, in place of the over-abstraction of groundwater for agriculture. Preliminary estimates of the current and future wastewater quantities are shown in **Table 4-5** below.

**Table 4-5 Wastewater Forecast**

| Item | 2003 | 2010 (Horizon, WAJ WW Dept) | 2030 (Horizon, Water Supply) |
|---|---|---|---|
| Population | 1,471,340 | 1,761,526 | 2,308,207 |
| Water Supply MCM/yr | 56.1 | 86.8 | 124.5 |
| Water Consumption MCM/yr | 27.8 | 64.3 | 112.1 |
| WW Generated (70% of consumption)[1] | 19.4 | 45.0 | 78.4 |
| Wastewater Collected and Treated MCM/yr | 10.2 | 17.4 | 31.1 |
| Ratio Collected/Supplied[2] | 18% | 20% | 25% |
| WW Treatment Plant Capacity MCM/yr | 15.1 | 37.4 | TBD |
| WW Untreated or via cesspits | 9.3 | 27.7 | 47.3 |
| WW Reuse water MCM/yr | 0.0 | 27.7 | 47.3 |

1. Civil Engineer's Reference Manual. Lindeburg, 1999
2. Forecasts for 2010 and 2030 are based on extrapolation of percentage collected in 2003, assuming that somewhat higher percentages will be collected in the future
3. Information on treatment plants capacity were obtained from WAJ.

### 4.4.3 Wastewater Treatment and Collection

In 2003, approximately 9MCM/yr of wastewater was generated that was not collected or treated; this volume was going directly into the ground via cesspits (which provide little to no treatment), or appearing as surface runoff. Of the portion going into cesspits, some amount of septage is being pumped out of the cesspits and taken to the Ekader septage disposal facility, where it is discharged into large lagoons. The actual volume transported to Ekader from the Northern Governorates has not been quantified. Based on WAJ's plans for sewerage and treatment to the year 2010, the amount of sewage not being treated at their facilities will have increased to approximately 28 MCM. Information on existing and

planned wastewater treatment plants (WWTPs) in the Northern Governorates are shown in Table 4-6 below. It is clear that great strides will need to be made towards improved wastewater collection and treatment by 2030 to avoid major environmental and health problems.

**Table 4-6 Existing and Planned Wastewater Treatment Plants**

| Treatment Facility | WWTP Type | Year Operational | Design Flow MCM/yr |
|---|---|---|---|
| **Existing** | | | |
| Irbid | Activated sludge + Trickling Filters | 1987 | 4.1 |
| Jerash | Activated sludge | 1983 | 1.3 |
| Kufranja | Trickling Filters | 1990 | 0.7 |
| Mafraq | Waste Stabilization Ponds | 1988 | 0.7 |
| Ramtha | Waste Stabilization Ponds | 1988 | 2.0 |
| Wadi Arab | Activated sludge | 1999 | 8.0 |
| Wadi Hassan | Activated sludge | 2001 | 0.6 |
| **Planned** | | | |
| Dair Abi Said | To be determined | 2015 | 1.1 |
| Kufranja Upgrade | Trickling Filters | 2008 | 1.9 |
| Mafraq Upgrade | Waste Stabilization Ponds | 2008 | 1.7 |
| Ghaza Camp-Jerash | Extended aeration | 2007 | 2.2 |
| Koufr Asad | To be determined | 2010 | 2.2 |
| North Jordan Valley | Extended aeration, polishing pond | 2010 | 4.4 |
| Torra | To be determined | 2015 | 1.1 |
| Wadi Shalaleh-Irbid | Activated Sludge | 2007 | 5.5 |

Source: WAJ annual reports and WAJ WWTP O&M Dept.

### 4.4.4 Impact of Untreated Wastewater

Calculations, shown in Table 4-5 above, indicate currently approximately 9 MCM/yr of sewage is primarily infiltrating into the groundwater with little or no treatment (although some becomes surface runoff into wadis and rivers, or is hauled to Ekader). This amount will increase to about 28 MCM/yr by 2010. It is clear that current planning does not cater to the anticipated wastewater volume in the near-term 2010 horizon, and that even greater strides will need to be made towards improved wastewater collection and treatment by 2030.

Historic trends [see USAID Water Quality Management Final Report, CDM 2002] have shown a steady increase in coliforms and nitrates in the groundwater. Nitrate concentration has been shown to decline after sewers are installed, and is a function of both wastewater and agricultural sources. Jordan's dilemma is two-dimensional: unregulated activities of a burgeoning population result in increasing groundwater pollution; and, these populations demand increasing quantities of high-quality drinking water. This region-wide quandary is made more acute in Jordan where water-scarcity forces abstraction of drinking water from potentially risky sources. The deteriorating source water quality demands increasingly sophisticated treatment technology - donor agencies are compelled to respond to the urgent need. However, high technology imported into a nascent, risk-averse regulatory framework can provide a false sense of security, rather than safeguarding public health. Considering that much of the Northern Governorates subsurface is carbonate rock, this is anticipated to contribute significantly to groundwater quality deterioration unless plans are put in place to improve collection and treatment commensurate with the increase in water supply.

This major potential threat to groundwater quality is being dealt with by the WAJ by an aggressive watershed management initiative. The WAJ is working both in the field by piloting watershed management programs as well as at the national level to create regulations for land use zoning and prohibiting activities that pose a groundwater threat.

### 4.4.5 Reclaimed Wastewater Reuse

Currently in the Northern Governorates, according to WAJ estimates, approximately 4 MCM of treated wastewater is reused annually for direct/local reuse in irrigation (formal reuse where effluent is sold to farmers); and 1.5 MCM is reused indirectly (treated effluent released to wadis and known to be diverted for irrigation). In reality, almost all reclaimed water is reused formally or informally. The MWI Planning Department and the WAJ Water Reuse Unit aim to increase this to 100% reuse by 2020. A country-wide wastewater reuse study is currently underway (USAID's Reuse for Industry, Agriculture and Landscaping Program), which will further institutionalize and increase reclaimed water use.

Formalizing reuse will have several beneficial effects: improvement in the quality of water applied to the surface, more efficient irrigation application methods (and reduction in evaporative losses), and use of the reclaimed wastewater in areas of higher agricultural productivity. This reuse will be available primarily in the Jordan Valley and in the lower portions of wadis, at ground elevations below those of the WWTPs. The agricultural reuse will be one of the elements in the overall program of reducing over-abstraction of groundwater in the northern Governorates, as discussed in more detail in Section 5.

As discussed in detail in Appendix C, the legal basis appears to be in place to support the re-allocations that changes in irrigation could require.